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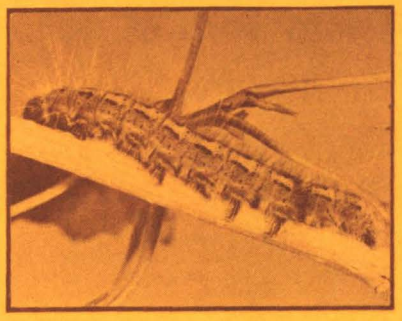

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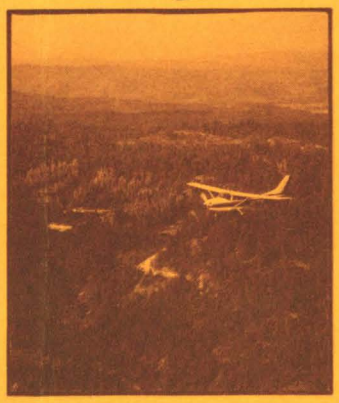

BRANCH OF FOREST INSECT AND DISEASE PREVENTION AND CONTROL
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Final Report

TRENDS OF A MOUNTAIN PINE BEETLE OUTBREAK IN YELLOWSTONE NATIONAL PARK, 1966 to 1972

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TRENDS OF A MOUNTAIN PINE BEETLE OUTBREAK IN YELLOWSTONE NATIONAL PARK, 1966 TO 1972

INTRODUCTION

The mountain pine beetle, ~Black Hills Beetle Dendroctonus ponderosae Hopkins, infestation in the southwestern corner of Yellowstone National Park was part of an outbreak that started on the adjoining Targhee National Forest in the early 1960's. The infestation intensified in the mature lodgepole pine stands and eventually spread into the Park in 1966.

Since there was little reliable information available to indicate the level of damage that could result during this outbreak, a study was initiated to determine the number and size of trees killed each year during the outbreak. The Park was selected as the study site because yearly trends could be measured in a natural environment without the direct influences of logging or chemical control.

REVIEW OF LITERATURE

The mountain pine beetle has been referred to as one of the most destructive forest insects in North America (McCambridge and Trostle, 1972). However, reported damage figures often have not been supported with survey data or statistical analyses. Several examples follow: Craighead, et al. (1931) stated that from 60 to 80 percent of the total number of trees over large areas were destroyed. Hopping and Mathers (1945) reported that 90 percent of the mature lodgepole pine over 150 square miles was killed. Struble and Johnson (1967) wrote, "Infestations in pure stands of lodgepole pine in the Rocky Mountains, Cascade Range, and Sierra Nevada often develop rapidly and maintain outbreak status until every tree more than 3 inches in diameter is killed." None of these articles included or had references which included survey data to support the damage figures.

Evenden and Gibson (1940) were the first to publish data on the results of surveys. They reported that 36 percent of the trees 3 inches in diameter and above were killed during the 1927 to 1938 outbreak on the Beaverhead National Forest, Montana. Unfortunately, they did not document their methods or provide statistical estimators of population parameters.

Two recent studies documented losses similar to those recorded by Evenden and Gibson (1940). Cole and Amman (1969) reported losses of 32 and 29 percent of all trees 4 inches and above in two areas on the Teton National Forest, Wyoming. Amman and Baker (1972) observed mortality levels from 10-38 percent of trees 4 inches in diameter and above in 10 areas on the Teton National Forest and in Grand

Teton National Park in Wyoming and on the Targhee National Forest, Idaho. Although the methods used by Cole and Amman (1969) and Amman and Baker (1972) were documented, statistical parameters were absent, and survey intensities were only 0.16 and 0.08 percent, respectively.

Since 1967, stand structure data depicting live and mountain pine beetle-killed trees have been collected in the Intermountain Region. These data closely approximate the percentages reported by Evenden and Gibson (1940), Cole and Amman (1969), and Amman and Baker (1972). For example, tree mortality ranged from less than 10 to 34 percent of all trees 7 inches and above in 11 areas sampled on the Teton National Forest.[1/] Also, Klein et al. (1972) reported that 45 percent of the host type and 37 percent of the total stand 5 inches and larger were killed near Arizona Lake, Grand Teton National Park. In other stands sampled, tree losses ranged from 10 to 45 percent of the total stands.

OBJECTIVES

Tree mortality data have been collected during and after outbreaks, but never each year during an outbreak. The objectives of this study were as follows:

1. To determine lodgepole pine mortality by diameter class on a yearly basis from the beginning to the end of the infestation.

2. To determine the number of living trees by diameter class before, during, and after the infestation.

METHODS

The survey was conducted in a 1-square-mile area (2 miles by 1/2 mile) in the extreme southwest corner of the Park. Eighty-five permanent plots were established in 1968 in a grid pattern at ten-chain intervals on five lines (17 plots per line) within the survey area. In the fall of 1968, green stand data were collected on every other plot on three of the five lines, 27 plots in all. Tree mortality was recorded on all 85 plots each year. However, attacks from three different years were recorded during the 1968 survey: 1968 current

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1/ Forest Insect Conditions on the Teton National Forest and in the Grand Teton National Park. 1967. 6pp. typed. (Copies available.)

attacks, 1967 mortality (faders), and all other mountain pine beetle killed trees were categorized as 1966 mortality. A survey conducted in 1966 showed that tree killing had just begun in the study area.1/ In subsequent surveys, it was possible to detect and amend mistakes made the previous year. Trees were recorded in 2-inch diameter classes. The variable plot method of cruising was used with a basal area factor (BAF) of 10 used on green stand plots and a 5 BAF on mortality plots. Tree counts and statistical calculations were obtained through the use of a computer program.

RESULTS AND DISCUSSION + No volume figures

In 1965, before the infestation reached the southwestern corner (Bechler area) of Yellowstone National Park, there were 211 live lodgepole pines per acre. The number of live trees per acre was reduced to 156 in 1972 (Table 1). At that time, 74 percent of the trees 5 inches and above were still alive. Only a few trees above 12 inches survived, but there was an adequate number of smaller trees to perpetuate the lodgepole forest (Figure 1). The percent survival would be higher if trees below 5 inches in diameter were included.

The mountain pine beetle killed 56 trees per acre in the study area during the 7-year-long infestation (Table 2). The peak level of mortality of 27 trees per acre occurred during the fourth year of the outbreak in 1969 (Figure 2). Incidentally, this level of mortality is the highest ever documented in the Intermountain area. Sizeable decreases in tree killing occurred in 1970, 1971, and 1972, and no further losses due to the mountain pine beetle are expected in subsequent years. Scattered tree killing due to secondary bark beetles is anticipated for 2 to 3 years following 1972.

The largest increase in mortality from one year to the next was 2.6 to 1. Migration of beetles from intense infestation centers on the Targhee National Forest possibly influenced this buildup. Ratios for new and old attacks by year follow: 1966 to 1967, 1.5:1; 1967 to 1968, 2.6:1; 1968 to 1969, 2.0:1; 1969 to 1970, 0.1:1; 1970 to 1971, 0.4:1; and 1971 to 1972, 0.2:1.

The survey data show 50 percent of the trees 8 inches and above were killed during the outbreak. This could be considered a serious impact in an area managed primarily for timber production. Conversely, the removal of the mature and decadent trees could be considered beneficial in some areas. In any event, the net impact of this insect in lodgepole pine forests is, for the most part, unknown. ?

1/ Forest Insect Conditions on the Targhee National Forest. 1966. 7pp. typed.

A statistical analysis of between plot variation for the number of trees per acre for the original green stand (in 1965 before tree killing began), yearly mortality, and total mortality is appended in Table 3. An intensive survey was conducted in the Park, and satisfactory statistical precision was obtained.

CONCLUSIONS

The unique aspect of this study was that it was possible to record tree mortality data each year during the outbreak. This eliminated the personal error that results when the year of mortality is predicted after an outbreak. Cole and Amman (1969) reported that trees could be dated by the year of mortality by foliar and bark characteristics. However, if the trees had not been marked by the year of mortality in the Yellowstone National Park study, it would have been impossible to accurately back-date mortality for more than 2 years.

During the 7-year-long mountain pine beetle outbreak in the southwestern corner of Yellowstone National Park, 26 percent of the trees 5 inches and above were killed. This level of damage, as well as that recorded in other areas, indicates that losses due to the mountain pine beetle are not as extreme as reported by some authors. This by no means implies that higher losses cannot occur or that similar losses are not serious under some situations.

Finally, the yearly trend data show that increases in tree killing from one year to the next did not exceed 2.6 to 1. The yearly trends of the beetle population are unknown, but emergence data were collected and the results of this study will be reported at a later date.

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APPENDIX

Table 1. The number of live trees per acre before, during, and after the mountain pine beetle outbreak in the southwestern corner of Yellowstone National Park.

	Live Trees/Acre							
	Diameter Classes							
Year	6	8	10	12	14	16	> 16	Total*
1965	79.8	62.7	39.8	17.0	8.0	2.1	2.0	211.4
1966	79.5	61.9	39.0	16.4	7.6	1.8	1.7	207.9
1967	79.5	61.1	37.9	15.1	6.4	1.5	1.3	202.8
1968	79.2	58.4	34.0	12.3	4.2	0.8	0.4	189.3
1969	77.1	50.3	23.4	8.1	2.2	0.5	0.3	161.9
1970	77.1	49.6	22.0	6.9	1.8	0.3	0.1	157.8
1971	77.1	49.1	21.4	6.7	1.6	0.2	0.1	156.2
1972	77.1	49.1	21.2	6.6	1.6	0.2	0.1	155.9

*Numbers have been averaged.

Table 2. The number of trees killed by the mountain pine beetle during the outbreak in the southwestern corner of Yellowstone National Park.

	Dead Stems/Acre*							
	Diameter Classes							
Year	6	8	10	12	14	16	> 16	Total
1966	0.3	0.8	0.8	0.6	0.4	0.3	0.3	3.5
1967	-	0.8	1.1	1.3	1.2	0.3	0.4	5.1
1968	0.3	2.7	3.9	2.8	2.2	0.7	0.9	13.5
1969	2.1	8.1	10.6	4.2	2.0	0.3	0.1	27.4
1970	-	0.7	1.4	1.2	0.4	0.2	0.2	4.1
1971	-	0.5	0.6	0.2	0.2	0.1	-	1.6
1972	-	-	0.2	0.1	-	-	-	0.3
Total	2.7	13.6	18.6	10.4	6.4	1.9	1.9	55.5

*Numbers have been averaged.

Table 3. Statistical estimators for original green stand, yearly mortality, and total mortality cruises conducted in the southwestern corner of Yellowstone National Park.

Stand Condition Measured*	Mean Per Plot	Standard Deviation	Standard Error	Confidence Interval About Mean (95% level)
1965 (Live Trees)	189.17	152.29	29.31	60.14
1966 Mortality	3.61	8.70	0.94	1.89
1967 Mortality	5.05	10.02	1.09	2.17
1968 Mortality	13.43	18.06	1.96	3.92
1969 Mortality	27.40	32.07	3.48	6.96
1970 Mortality	4.04	8.75	0.95	1.90
1971 Mortality	1.72	7.89	0.86	1.71
Total Mortality	55.50	38.52	4.18	8.36

* 1972 mortality results were not analyzed because only three infested trees were recorded on the 85 plots.

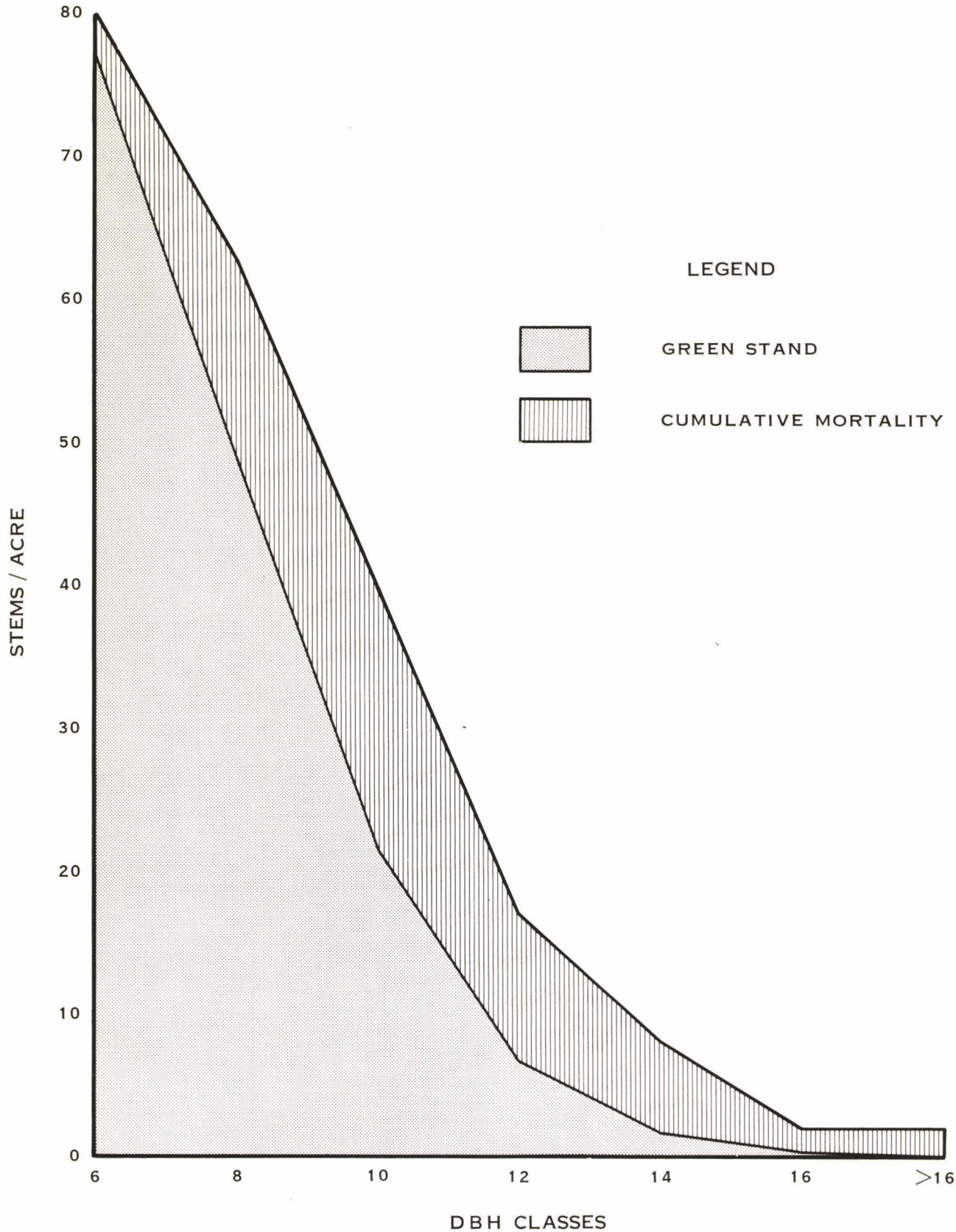

FIGURE 1. GRAPHIC REPRESENTATION OF STAND STRUCTURE IN THE SOUTH-WESTERN CORNER OF YELLOWSTONE NATIONAL PARK, 1972, AFTER SEVEN YEARS OF MOUNTAIN PINE BEETLE DEPREDATIONS.

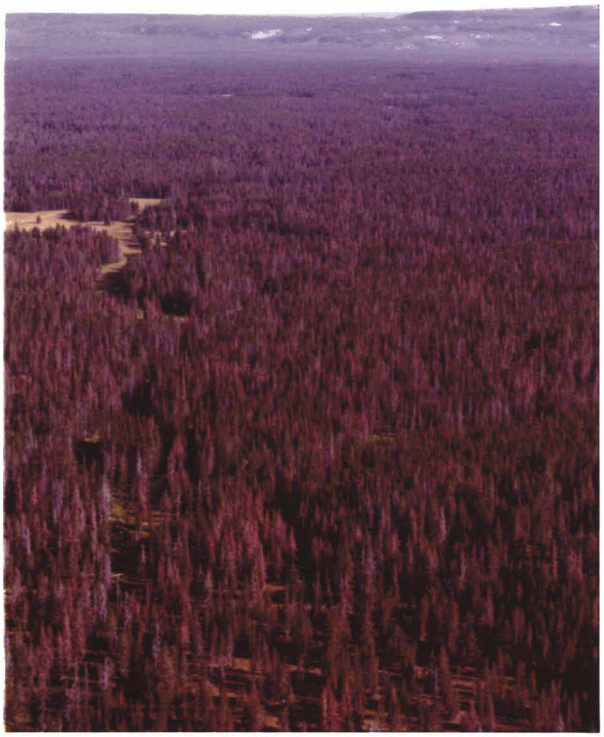

Figure 2. This 1970 aerial photograph of the southwestern corner of Yellowstone National Park and northward shows the cumulative mortality of 50 trees per acre killed by the mountain pine beetle. A 1969 survey revealed that there were 27.5 current "faders" per acre.